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209

DEPARTMENT CIRCULAR 209

THE WORK OF THE SAN ANTONIO EXPERIMENT FARM IN 1919 AND 1920

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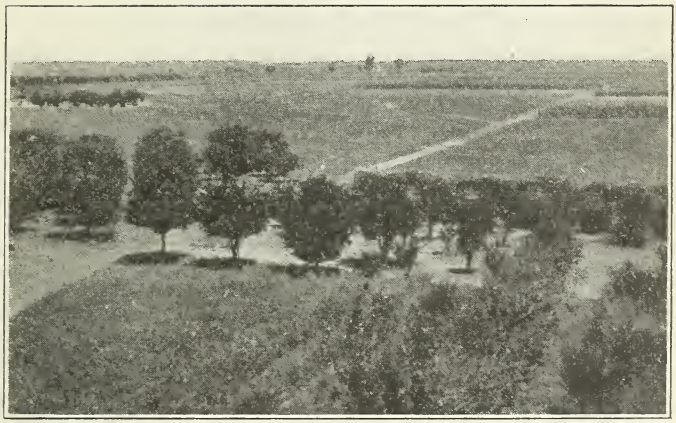

Portion of the San Antonio Experiment Farm, showing rotation and tillage fields, with orchard A-3 in the foreground.

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THE WORK OF THE SAN ANTONIO EXPERIMENT FARM IN 1919 AND 1920.

CONTENTS.

	Page.
Scope of the work of the experiment farm	3
Agricultural conditions in the region	4
Rotation and tillage experiments	9
Effect of different tillage practices	11
Experiments with cotton in 1920	15
Experiments with corn	19
Experiments with sorghums	26
Experiments with small grains	27
Experiments with field peas	29
Experiments with flax	31
Experiments for the control of cotton root-rot	32
Tests of Rhodes grass	33
Horticultural experiments	34
Experiments in crop utilization	36
Literature cited	39

SCOPE OF THE WORK OF THE EXPERIMENT FARM.

THE San Antonio Experiment Farm is devoted to experiments in rotation and tillage practices with field crops; breeding, selection, and cultural experiments with cotton; variety and selection work with corn and grain sorghums; tests of the various hay and pasture crops; and tests of newly introduced horticultural plants to determine their adaptability to local soil and climatic conditions and their economic value. The farm is maintained by the Office of Western Irrigation Agriculture of the Bureau of Plant Industry; but other offices of the Bureau cooperate in various lines of work, namely, Crop Acclimatization and Adaptation, Alkali and Drought Resistant Plant Investigations, Forage-Crop Investigations, Corn Investigations, Foreign Seed and Plant Introduction, and Biophysical Investigations.

The experiment farm is located 6 miles south of the city of San Antonio, near the southern border of what is known as the Black Prairie region of Texas. The soil of the experiment farm is a heavy black or dark-brown clay, carrying a high percentage of lime, and is characteristic of a large portion of the region.

During 1919 the work of the farm was continued along practically the same lines as in former years. In 1920, owing to a reduction in the appropriation, very little work was attempted other than to continue the rotation and tillage experiments; to carry on to a limited extent the variety, breeding, and selection work with cotton; and to maintain the perennial fruit and ornamental plantings. Maps of the experiment farm, giving the location of various plantings during 1919 and 1920, are shown in figures 1 and 2.

AGRICULTURAL CONDITIONS IN THE REGION.

CLIMATIC CONDITIONS.

The winter of 1918–19 was mild, with sufficient rainfall to provide adequate soil moisture for spring plantings. The minimum temperature for the winter, 21° F., was recorded on January 3. The last killing frost in the spring occurred February 28, and no damage was done to fruit trees or to ornamentals. The first killing frost of autumn came on November 28, giving a total frost-free period of 274 days. The mean monthly temperatures were below normal for every month except October. However, the unusually high humidity maintained throughout the summer made the heat very oppressive.

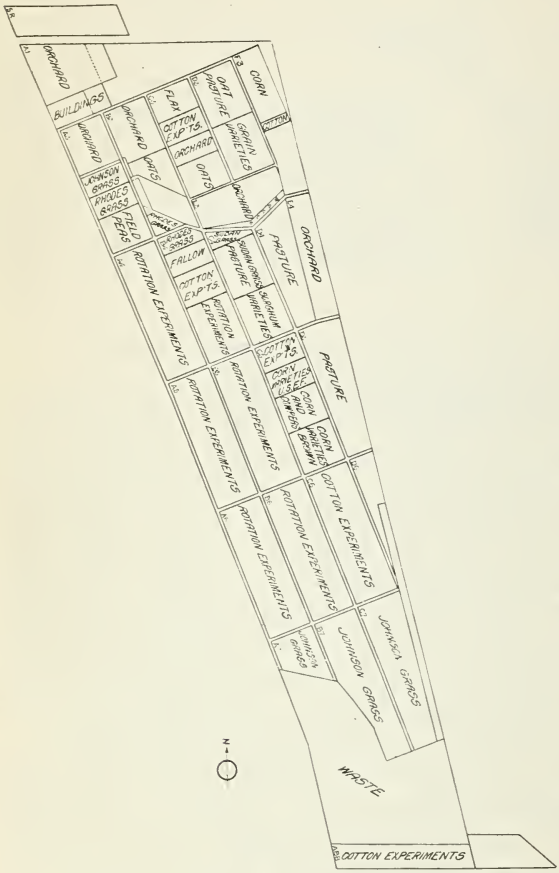

Fig. 1.—Diagram of the San Antonio Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1919.

The rainfall for 1919 was extraordinarily high. The total of 48.62 inches is the greatest reported for San Antonio since 1877. A precipitation of 0.01 of an inch or more was recorded on 127 days. The rainfall during February, April, May, November, and December was below normal, while that in July and October (7.60 and 11.06 inches, respectively) established records for those months. Excellent growth of sorghums and grasses was promoted by the abundant moisture supply, but the heavy and continuous rains which prevailed at harvest time prevented these crops from being saved in first-class condition. At the experiment farm only the third crop of sorghum was saved in fit condition for feeding. The total evaporation from a

free water surface was slightly more than 50 inches, the lowest ever recorded at this station and about 17 inches below the normal.

The mean monthly wind velocity was noticeably below normal during the year. As is usual in the region, however, occasional periods of high wind occurred. A severe windstorm on September 14 was accompanied by a heavy downpour. Ornamentals were damaged by having branches broken from them or by being entirely blown over. Only a small percentage of the first picking of cotton had been gathered at this time, and the remainder of the crop was badly damaged by being blown out of the bolls and beaten into the ground, or by the germination of the seed within the bolls, due to the extended period of wet weather which followed.

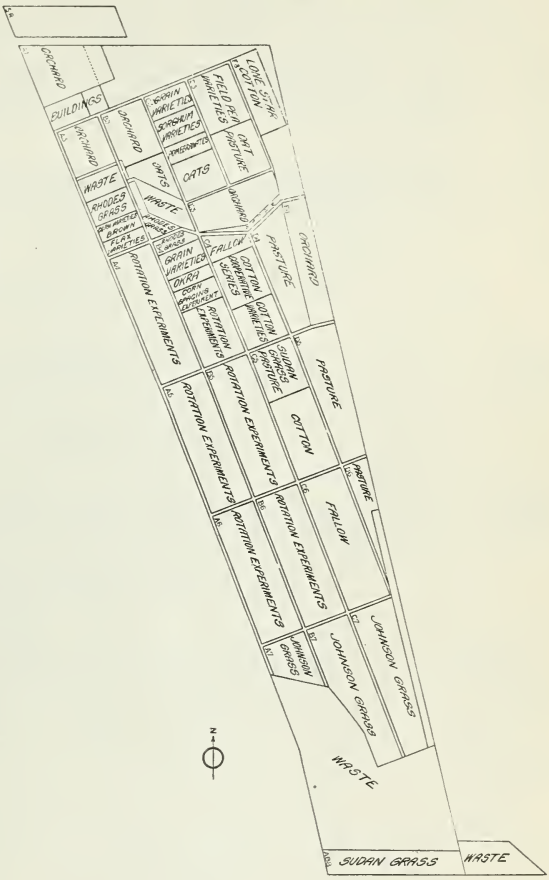

FIG. 2.—Diagram of the San Antonio Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1920.

The winter of 1919–20 was mild, with an abundance of moisture through the first half of January. After January 24 no precipitation of consequence occurred until May 7, when a series of frequent showers and wet, foggy mornings began and prevailed until the last of June. With the exception of a 12-day period from August 6 to 17, inclusive, the remainder of the year was seriously deficient in rainfall. The total precipitation for the year was 22.13 inches, as compared with an average rainfall from 1907 to 1920, inclusive, of 25.41 inches. The total evaporation from a free water surface for the year was 60.12 inches.

No serious extremes of temperature were experienced during 1920. However, a killing frost, 29° F., which occurred the night of April 4,

damaged tender truck crops, corn, and the new growth on shrubs and trees and materially decreased fruit yields by killing a large percentage of the fruit buds which had opened or had begun to swell. This frost occurred 12 days later in the spring than any other recorded at this station during the past 14 years. The first killing frost of autumn occurred the night of November 14 (31° F.), giving a frost-free period of only 224 days for the season of 1920, which is 31 days less than the average number reported at the experiment farm for the 14-year period from 1907 to 1920, inclusive.

A summary of the meteorological data covering the last 14 years is given in Table 1.

TABLE 1.—*Summary of meteorological observations made at the San Antonio Experiment Farm, for the 14-year period from 1907 to 1920, inclusive.*

Item.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
PRECIPITATION (INCHES).[a]												
Average for 14 years, 1907 to 1920	1.13	1.51	1.34	3.11	3.09	1.88	2.12	1.87	2.57	3.42	2.27	1.72
For 1919	3.88	1.57	1.74	2.52	2.86	5.79	7.60	2.22	7.06	11.06	.51	1.82
For 1920	4.00	.19	.49	.51	3.78	5.10	1.66	2.39	.03	1.91	1.97	.10
EVAPORATION (INCHES).[b]												
Average for 14 years, 1907 to 1920	2.53	3.08	4.61	5.80	6.58	8.32	9.28	8.80	6.93	5.16	3.14	2.47
For 1919	1.79	2.48	3.04	5.50	5.52	5.81	5.64	7.06	5.16	3.73	2.77	2.06
For 1920	1.31	2.56	4.37	7.23	6.25	6.05	7.14	7.03	7.18	5.21	2.80	2.99
DAILY WIND VELOCITY (MILES PER HOUR).												
Highest:												
1911 to 1920	11.4	15.9	11.9	10.6	10.2	11.9	12.5	12.6	12.7	8.5	11.0	8.6
For 1919	6.4	8.4	6.7	8.3	5.3	5.0	5.2	4.5	12.7	5.3	4.5	8.4
For 1920	11.4	4.9	8.0	6.9	7.5	4.4	4.6	3.0	4.3	6.3	5.8	8.6
Lowest:												
1911 to 1920	.5	.1	.2	.3	.1	.5	.6	.5	.4	.3	.4	.3
For 1919	.9	.1	.2	1.3	.9	.5	.6	.7	.5	1.0	.6	.9
For 1920	.7	.9	1.1	2.0	1.2	.6	1.2	.8	.5	.7	.8	.9
Mean:												
1911 to 1920	3.5	3.8	4.1	4.1	3.8	3.5	3.4	3.1	2.8	2.6	2.6	2.9
For 1919	2.9	3.6	3.4	3.7	2.5	2.5	2.0	2.1	2.4	2.9	1.9	2.4
For 1920	3.3	3.2	4.5	4.5	3.7	2.0	2.2	1.9	2.1	2.8	2.9	3.4
TEMPERATURE (° F.).												
Absolute maximum:												
1907 to 1920	88.5	93.0	95.5	102.0	103.0	108.0	108.0	107.0	104.0	98.0	90.0	85.0
For 1919	72.0	86.0	83.0	85.0	92.0	94.0	97.0	98.0	95.0	90.0	83.0	75.0
For 1920	80.0	89.0	86.0	101.0	94.0	92.0	98.0	98.0	101.0	98.0	85.0	85.0
Absolute minimum:												
1907 to 1920	9.0	13.0	17.0	32.0	39.0	47.0	60.0	56.0	41.0	24.0	15.0	15.0
For 1919	21.0	26.0	34.0	39.0	50.0	47.0	67.0	68.0	58.0	53.0	32.0	24.0
For 1920	26.0	24.0	28.0	29.0	57.0	61.0	67.0	67.0	43.0	40.0	22.0	19.0
Mean:												
1907 to 1920	51.3	53.9	62.5	67.9	75.0	82.5	84.5	83.7	79.0	69.4	59.7	51.0
For 1919	49.0	51.0	60.0	67.0	73.0	78.0	80.0	82.0	77.0	74.0	60.0	50.0
For 1920	48.0	55.8	59.5	68.4	77.2	77.8	82.7	82.6	82.2	70.8	56.3	52.5

[a] Total precipitation (inches): Average for 14 years, 1907 to 1920, 25.14; for 1919, 48.63; for 1920, 22.13.

[b] Total evaporation (inches): Average for 14 years, 1907 to 1920, 66.70; for 1919, 50.56; for 1920, 60.12.

TABLE 1.—*Summary of meteorological observations made at the San Antonio Experiment Farm, for the 14-year period from 1907 to 1920, etc.*—Continued.

KILLING FROSTS.

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		°F.		°F.	Days.
1907	Feb. 8	29	Nov. 12	32	277
1908	Feb. 20	24	Nov. 14	29	268
1909	Feb. 25	30	Dec. 6	31	284
1910	Feb. 25	26	Oct. 29	32	246
1911	Feb. 25	29	Nov. 13	31	261
1912	Feb. 27	30.5	Nov. 2	29.5	245
1913	Mar. 17	26	Oct. 27	29	224
1914	Mar. 23	29	Nov. 20	31	242
1915	Mar. 22	24.5	Nov. 15	27	238
1916	Feb. 20	32	Nov. 14	29	268
1917	Mar. 5	17	Oct. 29	24	238
1918	Feb. 21	32	Nov. 30	27	282
1919	Feb. 28	32	Nov. 29	32	274
1920	Apr. 4	29	Nov. 14	31	224

CROP CONDITIONS.

Cotton, the main crop of the region, had an exceptionally poor season in 1919. The climatic conditions were favorable for the development of the boll weevil, and that pest was present in very destructive numbers. Of the comparatively small crop of cotton which was produced only a few pounds per acre had been picked previous to the severe wind and rain storm of September 14, and little cotton of value was picked after that time. Not a pound was harvested from many large areas.

The season was excellent for corn. Observations indicated that this crop suffered very little for want of moisture. In a cooperative test, however, Laguna corn grown under irrigation on the Medina Irrigation Project made a yield of 98½ bushels per acre, as compared with a yield of 70 bushels per acre from an adjacent plat not irrigated.

Forage crops yielded well, but their value was very much reduced by wet weather at the time of harvesting. Oats yielded higher than ever before at the experiment farm, an average yield of 43 bushels and a maximum of 56 bushels per acre being recorded. Yields of wheat, barley, and rye were good. These three crops have usually given very small returns and have been considered as poorly adapted to local conditions.

The season of 1920 was more favorable to cotton, and such other crops as corn, sorghum, oats, and pastures did exceptionally well. Numerous rains throughout the fall of 1919 and until the latter part of January, 1920, put plenty of moisture in the soil for planting corn and the sorghums. Dry weather throughout February, March,

and April, however, prevented the planting of cotton until the second week of May. Boll weevils were present in large numbers as soon as the earliest cotton emerged. Sufficient rain fell during May and June to produce profitable yields of corn and hay sorghums. A large part of the first cutting of hay from early sorghums was lost by being caught in the swath or windrow by rains, which, while not heavy, were almost continuous for a period of 25 days during June. The yield of Laguna corn on the experiment farm was at the rate of 49.7 bushels per acre, which was considerably above the average yield over a period of years.

Sorghum midges were responsible for practically a complete failure of the grain-sorghum crop. For the first time on record fields of milo which were planted as early as March 4 failed to produce grain, owing to the presence of this pest.

ECONOMIC CONDITIONS.

In spite of the low yields of cotton in 1918, the high price received for that crop caused many farmers to continue a large acreage in 1919. The number of gin-run bales for Bexar County was 9,430, as compared with an average of 21,726 equivalent 500-pound bales per year for the 13-year period from 1905 to 1917, inclusive. The crop was more difficult to gather than usual, owing to rank plant growth; hence, unusually high prices for picking prevailed. While corn yielded exceptionally well, this crop was not generally grown beyond the limits of irrigation. The large yields of forage crops were so badly damaged by wet weather that their value was little, if any, more than their cost of production. It was not possible for the ranchers to avail themselves fully of the excellent range conditions, because of having greatly reduced their herds during the preceding three years of drought. The economic status of the farmers of the region was not improved during 1919.

In 1920, although cotton planting was delayed from two to three weeks by the dry weather of February, March, and April and although the unusually early, heavy infestation of boll weevils materially checked the production of cotton, that crop made excellent use of the rains coming in May and June and produced, on the average, very satisfactory yields. Only a comparatively small part of this cotton was sold before the price of the staple dropped below the cost of production. From $1.50 to $2 per 100 pounds was paid for picking the crop, and laborers were hard to get at that price. Rainfall conditions were favorable for the production of winter grain, corn, and the hay crops, and good yields of all were harvested. The corn crop, especially, was well above the average.

Farmers of the region showed an active interest in hogs at the beginning of the season. However, after they had paid high prices for their breeding stock and for feedstuff through the fore part of the year the market dropped to so low a point that no profit was realized, and much discouragement from this source prevailed. Dairy farmers, on the whole, received very good prices for their milk products. Those who produced their own feed made good returns, while others who had to depend in whole or in part on buying in a high feed market did little more than break even.

In 1920, 10 to 15 per cent of the cultivated area of the region was allowed to remain idle, the chief reason being scarcity of labor and inability to get land plowed and in condition for planting owing to wet weather during the fall and winter.

ROTATION AND TILLAGE EXPERIMENTS.

A very important part of the work of the San Antonio Experiment Farm is the testing of various crop sequences and cultural methods. These experiments occupy 95 quarter-acre plats and 4 fifth-acre plats in fields A and B, as shown in figures 1 and 2. There are 26 two-year; 4 three-year, and 5 four-year rotations. Except for Sudan grass, continuous cropping is practiced with all crops grown, 15 plats being used for this purpose. The fifth-acre plats are used for 2 two-year rotations to determine the value of bordering land to prevent the run-off of rain.

The rotation and tillage experiments, in practically their present form, were begun in 1909, but certain additions and modifications have been made since. Dwarf milo replaced corn in several of the rotations in 1911, and a new 3-year rotation, including Sudan grass, was added in 1913. Sudan grass was substituted for oats in a 2-year rotation in 1914, since which time no modifications have been made. In 1920 the fall-seeded crops were harvested and all spring-seeded crops were planted as in previous years. After July 30 no further plantings were made, fall plowing and the harvesting of spring-seeded crops being the only work attempted.

The yields of the several crops grown in the rotation experiments for the years 1919 and 1920, together with their average yields during the 12-year period from 1909 to 1920, inclusive, are given in Table 2.

The 1919 yields of all crops except cotton were much greater than the average yields for the period 1909 to 1920. The yields of oats, both for hay and for grain, were much higher than ever before. Cotton yielded less than 10 per cent of the average for the period.

The low yield was due to the work of the boll weevil and to unfavorable weather conditions. The production of cotton on the different plats was so severely affected by these factors that their yields were rendered of little or no comparable value. Sorghum is grown continuously on five plats. Two of these plats are planted in 4.1-foot rows and cultivated, and the other three are drilled in 8-inch rows. Probably half the crop from the latter in 1919 consisted of pigweed and Johnson grass. The pigweed is troublesome on only two of these plats which are manured regularly. Johnson grass is less difficult to control where the sorghum is planted in 4.1-foot rows and cultivated.

TABLE 2.—*Comparison of yields per acre of crops in the rotation experiments on the San Antonio Experiment Farm in 1919 and 1920.*[a]

Crop.	Unit of yield.	Number of plats.	Yields in 1919.			Yields in 1920.			Average yield, 1909 to 1920.
			Average.	Highest.	Lowest.	Average.	Highest.	Lowest.	
Seed cotton	Pound	30	42	110	4	433	740	80	477
Corn	Bushel	21	48.9	54.6	43.2	49.6	66.3	36.6	26.3
Milo	do	14	30.7	47.1	17.4	(b)	(b)	(b)	c 25.4
Oats for grain	do	8	42.8	55.7	23.4	26.6	36.1	13.3	14.5
Sorghum, 4.1-foot drills	Ton	5	7.29	8.35	6.09	4.03	5.34	2.84	4.35
Sorghum, 8-inch drills	do	7	8.75	9.58	6.72	8.51	11.84	3.62	4.96
Sudan grass	do	2	8.39	8.88	7.90	6.13	6.92	5.34	d 5.65
Oats for hay	do	8	3.31	3.79	2.11	2.17	2.47	2.02	1.72

[a] The average given is for the years during which the crop has been grown in the rotations during the 12-year period from 1909 to 1920, inclusive, except as otherwise noted.
[b] The complete failure of the milo crop was due to sorghum-midge infestation.
[c] From 1912 to 1920.
[d] From 1913 to 1920.

In 1920, with the exception of Dwarf milo, which was a complete failure as a result of the unprecedented early infestation of the sorghum midge, all crops in the rotations gave fair to excellent yields. Cotton yielded on an average slightly less than one-third of a bale to the acre, in spite of the fact that planting was delayed fully three to five weeks by dry weather which occurred during the early part of the season. The plentiful rainfall of the winter months, together with moderate temperatures, produced very satisfactory yields of oat hay. When the rains of the winter stopped, the heavy plant growth of the oats rapidly dissipated the soil moisture, and the drought which resulted at the time the seed was being made, without doubt, caused a severe decrease in the yields of grain.

Corn was planted the last of February. The soil contained plenty of moisture, and most of the plats were in excellent tilth. A growth of 4 to 6 inches had been made when a freeze occurred the night of April 4 and a large percentage of the young plants were killed to the ground. During the favorable weather which followed, the corn revived rapidly, and it was noted that those plats which apparently

had suffered most severely were the first to show full recovery. The average yield of 49.6 bushels per acre for 1920 was above that recorded for 1919 and has been exceeded in the rotation fields in only one season during the past 12 years.

Sumac sorghum was seeded in the rotations on March 13, 1920, and good stands were obtained on all except two spring-plowed plats. Although these were plowed, disked, harrowed, and seeded while the soil was yet moist, the loose condition allowed the soil to dry so rapidly that the young seedlings soon died for lack of moisture. Reseeding was done on May 16, and excellent stands obtained. They yielded at the rate of 5.59 and 6.53 tons, respectively, of clean, well-cured hay per acre. Two fall-plowed plats seeded to sorghum in 8-inch drills, following corn and cotton, respectively, in 2-year rotations, made a yield of clean, well-cured hay of 11.83 tons per acre, in two cuttings. The yield from a comparable plat which had been planted continuously to sorghum for the past 12 years was at the rate of only 3.62 tons per acre, 90 per cent of which was estimated to be Johnson grass.

Rotation has given higher yields than continuous cropping. This is true in spite of the fact that the soil is very fertile and not easily exhausted. The increase in yield is not so great in years of good rainfall, such as 1919 and 1920, but the advantage in the control of weed pests is greater. The results obtained in each of the three seasons preceding 1919 demonstrated quite plainly the value of the early preparation of land. This factor did not show to so great advantage in the past two years of plentiful spring moisture. A more satisfactory distribution of labor and the fact that moisture shortage is the usual condition in this region are strong arguments for fall or early-winter plowing. Weeds and insects are more easily controlled by early plowing, and a satisfactory seed bed is seldom obtained where preparation of the land is postponed until spring.

EFFECT OF DIFFERENT TILLAGE PRACTICES.

For convenience in studying the different tillage experiments, they are considered under the following groups: (1) Manuring, (2) green-manure crops, (3) subsoiling, (4) bordering, (5) biennial cropping, and (6) rotation and tillage as factors in the control of cotton root-rot.

MANURING.

To study the effect of manure, four comparisons are made with cotton, one with oats, and two each with corn and milo, all in rotation with other crops. One plat each of corn, milo, cotton, and sorghum continuously cropped and manured each year are comparable to plats of the same crop similarly treated in every way

except that no manure is applied. One plat is cropped continuously to sorghum and receives manure each alternate year. Barnyard manure, practically free from straw and other coarse material, is used at the rate of approximately 16 tons per acre. Manuring has increased the yields of cotton, milo, and hay sorghums. Oats for hay have given practically equal yields from manured and unmanured plats. There are no strictly comparable plats of oats for grain with and without manure, but observations of rotations including oats for grain with manure indicate that invariably the application of manure decreases the yield of grain by encouraging excessive plant growth. This is more noticeable in years of low rainfall. In 1919 and 1920 corn yielded slightly less in rotations receiving manure, although over a period of years the average is slightly in favor of manuring. The beneficial effect on all crops is greater in years of comparatively heavy rainfall. However, the benefits derived are insignificant at best, and the increased returns do not justify the practice where additional expense is incurred by the application of manure to field crops.

GREEN-MANURE CROPS.

Rye and cowpeas have been grown in various rotation experiments since 1909, and field peas since 1913. In a 2-year rotation of corn and cotton, rye is seeded in the corn stubble in November after the land has been well disked. It is turned under in the spring, usually the latter part of February or first of March, previous to planting cotton. Ordinarily the rye makes very little growth, and its manurial effect has been negligible. Spring plowing invariably leaves a poorer seed bed than earlier preparation. The average yield of seed cotton from this rotation during the 12-year period from 1909 to 1920, inclusive, is 391 pounds, as compared with an average yield of 575 pounds from a rotation which is similar except that no rye is grown and the corn plat is merely disked in July after the removal of the crop.

Cowpeas for green manure are grown after oats for grain in two 4-year rotations. The oat stubble is plowed and cowpeas seeded in 3-foot rows immediately following the removal of the oat crop. In the fall of 1918 a growth of cowpeas estimated at 7 tons of green material per acre was plowed under, while in 1919 the growth was estimated at approximately 3.5 tons per acre. In most years there is not sufficient moisture to produce an appreciable growth of cowpeas, and in no instance has there been any increase in the yield of cotton following which could be ascribed to the green manure plowed under.

Field peas have been grown for green manure on five plats and for hay on one plat for the past eight seasons. They have produced fair to good growth five seasons and practically no growth the other three

seasons. Seeding is done early in November and the resultant growth of green manure is plowed under in the spring. Sorghum follows the peas on two plats and cotton on four plats. The yields of sorghum have not been materially increased by the green manure in any season. In years of low spring rainfall it has been very difficult to obtain a stand, owing to the drying out of the soil as a result of the spring plowing which the growing of a winter legume makes necessary. The effect of field peas on the yield of cotton appears to be even less than its effect on sorghum. The conclusion must be that the use of field peas as a green-manure crop is not to be advised from an economic standpoint, and their use may even cause a decrease in the yield of the crop following in seasons of low spring rainfall.

SUBSOILING.

Subsoiling is practiced on nine plats. Three plats are subsoiled in the fall, two in preparation for corn and one for cotton; three are subsoiled in the spring, two for corn and one for cotton; two are subsoiled in July for cotton; and one is subsoiled in June for corn. The results of 1919 and 1920 substantiate the conclusions drawn in previous seasons (7;[1] 9, p. 12–13). When subsoiling was done in the spring shortly before planting, the yield of corn was depressed 1.5 to 3.8 bushels per acre, and a decrease of 60 pounds of seed cotton per acre was shown. The residual effect of summer and fall subsoiling was much less marked, and the small differences in yields from comparable plats were not significant.

BORDERING.

The practice of throwing a bank of earth around comparatively level land to prevent run-off of rain has been carried on since 1911. Four plats in field A4, numbered 7 to 10, inclusive, are used for this work. The crops grown, together with the time of plowing the land, are as follows: (1) Corn, plowed in July, and cotton, plowed in November, in a two-year rotation; (2) sorghum in 4.1 foot rows, plowed in November, followed by a year of fallow. In no case has there been any consistent beneficial effect due to bordering. The yields of corn have been consistently low since the beginning of the experiment. Cotton has shown a greater tendency to vary in comparison with yields from other cotton plats. Sorghum in this experiment has ranked well with respect to other plats, but has shown no indication of increased yields in seasons of low rainfall. From a survey of carefully kept soil-moisture records covering the entire duration of these experiments it has been found that no more moisture is held by these bordered plats than is retained by the unbordered ones. To

[1] The serial numbers in parentheses refer to "Literature cited" (p. 39).

make bordering at all effective on the ordinary farm the area contained within each border would necessarily be comparatively small; perhaps the larger borders might include 2 or 3 acres. The cost of such bordering would be considerable, and nothing has been indicated by these experiments that would justify the additional expense.

BIENNIAL CROPPING.

Four crops—cotton, corn, oats for grain, and sorghum in 4.1 foot rows—are grown biennially in the rotation and tillage experiments. Two plats, cropped and fallowed alternately, are devoted to each of these crops. As soon as the crop is harvested the plat is plowed. It is then kept in good tilth and free from weeds by disking and harrowing whenever necessary throughout the following season.

Corn on biennially cropped land produced 43.4 and 38.6 bushels per acre in 1919 and 1920, respectively, as compared with yields of 52.0 and 51.1 bushels per acre, respectively, from land cropped continuously to corn. With the exception of two years, the results have been similar every season since the experiments were begin in 1910. The yields of seed cotton in 1919 and 1920 from biennially cropped land were at the rate of 8 and 80 pounds per acre, respectively, while the average yields from two continuously cropped plats were at the rate of 77 and 382 pounds per acre, respectively. Excluding the yields for 1919, which are not considered as significant, the average yield per acre from the biennially cropped plats for the period 1910 to 1920, inclusive, is 343 pounds of seed cotton, as compared with a similar average of 447 pounds of seed cotton per acre from the two continuously cropped plats. Oats on land cropped biennially yielded at the rate of 52.1 and 24.7 bushels per acre, respectively, in 1919 and 1920, while on a plat continuously cropped to oats for the past 12 years the yields were at the rate of 52.9 and 36.1 bushels per acre. These are the first seasons in which the continuously cropped plat has outyielded the biennially cropped plat of oats. On plats biennially cropped to sorghum in 4.1-foot rows the yields were 8.35 and 2.84 tons per acre in 1919 and 1920, respectively. The average yields from two comparable plats, cropped continuously to sorghum and receiving no manure, were 6.61 and 3.37 tons per acre. The average yields during the 10-year period from 1911 to 1920, inclusive, were at the rate of 4.72 tons per acre for the biennially cropped plats and 3.92 tons per acre for the continuously cropped plats.

Corn and cotton each show a decrease in yields due to biennial cropping as compared to continuous cropping, while the reverse apparently holds true as regards oats and sorghum. However, it must be remembered in comparing the latter crops that in the case of biennial cropping only half the land is in crop each year. From

the standpoint of crop production there appears to be no justification for a long period of fallow in the San Antonio region.

ROTATION AND TILLAGE AS FACTORS IN THE CONTROL OF COTTON ROOT-ROT.

The investigations dealing with cotton root-rot and its control were continued throughout 1919 and 1920. In 1919, counts were made of all plants dead on all cotton plats at intervals during the season, beginning June 21 and ending October 31. During 1920 the counts were made semimonthly from June 30, at which time the first affected plants were noticed, until November 4. Diagrams showing the exact location of affected areas were made of all plats at the end of each season, and during 1920 such diagrams were made of four continuously cropped cotton plats at each semimonthly period. At the end of the 1919 season 26 per cent of all plants in the rotation fields were recorded as dead from root-rot, while at the close of 1920 only 13.1 per cent of all plants were dead from this cause.

In summarizing the data accumulated during the 5-year period from 1916 to 1920, inclusive, the following facts are observed:

(1) The percentage of plants killed by root-rot has been higher in wet than in dry seasons.

(2) During four seasons the application of barnyard manure just ahead of the cotton appreciably decreased the number of dead plants as compared with similar rotations receiving no manure. In 1918 the reverse result was recorded.

(3) Land plowed in the fall or late summer in preparation for cotton has consistently shown a lower infection of root-rot than land which is not broken until spring.

(4) Subsoiling in connection with fall or late-summer plowing has shown no consistent effect on the subsequent loss from root-rot.

(5) Subsoiling in connection with spring plowing has appreciably increased the percentage of plants dead from root-rot, as compared with land which is spring plowed but not subsoiled.

So much is yet to be learned regarding the nature and cause of this serious plant disease that it is not considered safe as yet to make recommendations concerning its control.

EXPERIMENTS WITH COTTON IN 1920.[2]

The experiments with cotton were conducted in cooperation with the Office of Crop Acclimatization and Adaptation Investigations, as in previous years. A variety test and a cultural experiment were planted, and breeding work with the Kekchi, Acala, and Lone Star varieties was continued.

The season of 1920 was rather unusual in that a good crop of cotton was made under a continuous boll-weevil infestation. Dry weather prevented planting until the latter part of May, but a good stand was

[2] This cotton was planted by Mr. G. W. R. Davidson and harvested by Mr. H. G. McKeever, who reported the results.

obtained and the young plants grew rapidly. Even before the first squares appeared boll weevils were present in large numbers, feeding on the buds and on ratoon sprouts and earlier planted cotton in the vicinity. At this time much damage was done by the weevils in puncturing the terminal buds and causing them to abort.

Conditions favored a rapid multiplication of the boll weevils up to the first week in July, and though many squares were produced practically all of them were destroyed. During the second week in July hot, dry weather prevailed, which checked the multiplication of the weevils. It was during this period, from about the middle of July to the middle of August, that the crop was made. During the latter part of August conditions were again favorable for the weevils, which soon became so numerous that they nearly prevented flowering and injured many of the young bolls, less than an inch in diameter. Thus the crop was not made by the plants producing enough flowers to make a crop before the weevils became very numerous, but under conditions that enabled the weevils to destroy all of the first squares. Notwithstanding this loss, the hot, dry weather during the latter part of July and the first part of August checked the weevils enough to allow flowers and young bolls to set in sufficient numbers to make a crop.

The variety test included Kekchi, a Guatemalan variety with lint averaging about $1\frac{1}{4}$ inches in length; Acala, a Mexican variety the lint of which is $1\frac{1}{8}$ to $1\frac{3}{16}$ inches long; Lone Star, Kasch, Triumph, Rowden, and Truitt, popular Texas big-bolled cottons. The Lone Star variety has lint which is from 1 to $1\frac{1}{16}$ inches in length under San Antonio conditions, while the lints from the other Texas big-bolled varieties do not exceed an inch. These varieties were planted in 4-row blocks. The rows were 264 feet long and 4.1 feet apart, so that each block occupied about one-tenth of an acre. Guard blocks on each side of the experiment were planted with Lone Star. A block of Lone Star was planted between each of the above-mentioned varieties to act as a check, so that every alternate block in the experiment was of Lone Star. With this method of planting, each variety can be compared with the adjoining check blocks. All of the Lone Star blocks were planted from the same stock of seed, so that the results might serve to indicate whether any variety or block had been favored by soil conditions.

Though Kasch ranked first in yield, it produced fiber averaging only fifteen-sixteenths of an inch in length, and the money value of Acala, which was a close second in yield and has fiber $1\frac{1}{8}$ to $1\frac{3}{16}$ inches in length, would have been greater, as premiums as high as $50 a bale have been paid for lint of this variety. Kekchi, which was third in yield, would rank close to Acala in money value, with

fiber 1¼ inches in length and of fine quality. The other four varieties ranked as follows: Truitt, fourth; Triumph, fifth; Rowden, sixth; and Lone Star, seventh. Though Lone Star in this comparison yielded somewhat less than the other Texas big-bolled cottons, the differences were too small to be significant, and as Lone Star fiber is from one-sixteenth to one-eighth of an inch longer than the fiber of the others it probably would equal or surpass them in money value.

In previous variety tests at San Antonio all varieties have given approximately the same yield, but even in this case Acala would have a distinct advantage due to the long fiber (8, p. 13; 9, p. 16).

Cultural experiments conducted in former years have indicated that under San Antonio conditions maximum yields are most likely to be produced by plants not wider apart in the row than 12 inches, and perhaps the optimum spacing is somewhat under this. In view of these results the cultural experiment conducted at San Antonio in 1919 consisted of a comparison of plants thinned to 6 and 12 inches apart in the row. Lone Star was the variety used in this experiment. The season of 1919 was, however, the most unfavorable for cotton in the history of the work at San Antonio, and no yields were recorded.

In 1920 this experiment was repeated, again with Lone Star seed. The experiment consisted of 10 four-row blocks, each block about one-tenth of an acre, as in the variety test. Guard blocks were planted on each side of the experiment in order to eliminate the effect of outside rows. The experiment was planted on May 26 at the rate of 24 pounds per acre in order to obtain a good stand which would enable the plants to be spaced regularly. On July 1, 36 days after planting, the cotton was thinned. The plants in blocks 1, 3, 5, 7, and 9 were thinned to 6 inches apart in the row, and those in blocks 2, 4, 6, 8, and 10 were thinned to 12 inches. Thus the experiment consisted of alternate blocks spaced 6 and 12 inches, to make the comparisons as direct and definite as possible. Table 3 gives the block yields from this experiment. All 6-inch blocks produced more cotton than adjacent 12-inch blocks. The last column in the table gives the percentage of this increase. The yield from all 6-inch blocks, as compared with the yield from all 12-inch blocks, gave an increase of 45.1 per cent in favor of the 6-inch spacing. Vegetative-branch counts showed that the 6-inch spacing was much more effective in reducing the number of vegetative branches, since the average number of these branches per plant in the 6-inch spacing was only 0.56, while in the 12-inch spacing it was 1.31.

Previous experiments have shown that close spacing increases the earliness of the crops by reducing the number of wood limbs or vege-

tative branches, thereby increasing the yield by enabling flowers to be produced before the weevils become numerous enough to cause serious damage (1, 3, 4, 5, 10). This year's results, however, indicate that larger yields can be obtained from close-spaced plants even in a season when the early buds are destroyed by the weevils.

TABLE 3.—*Yield of seed cotton from tenth-acre plats thinned to 6 and 12 inches apart in the row on the San Antonio Experiment Farm in 1920.*

Variety.	Spaced 6 inches.			Spaced 12 inches.			Increase of close spacing over wide.
	Block.	Yield.		Block.	Yield.		
		Lbs.	*oz.*		*Lbs*	*oz.*	*Per cent.*
Lone Star	1	41	..	2	28	6	44.5
Do	3	32	10	4	26	12	22.0
Do	5	34	8	6	25	8	35.3
Do	7	33	..	8	20	12	59.0
Do	9	27	..	10	14	8	71.4

The reduction in the number of vegetative branches on the closer spaced plants keeps the rows narrower and allows more sunlight to reach the base of the plants, thereby increasing the chances of drying and killing the weevil larvæ contained in the falling squares and also maintaining more favorable conditions for ripening the crop. Rank spreading plants with large vegetative branches are not well adapted to withstand a drought, which is frequently the cause of very serious blasting and shedding of the buds or young bolls. Single-stalk plants are also in a better physiological state for producing and retaining buds or young bolls. For this reason plants that were spaced to 6 inches probably retained a much larger percentage of the squares produced during the drought, which lasted from about the middle of July to the latter part of August, than did the wider spaced plants. As the bolls had to be set during the dry weather if a crop was to be made, the better drought-resistant qualities of the smaller plants, spaced at 6 inches, resulted in a very real advantage.

The results of these cultural experiments indicate that when the season at San Antonio is at all favorable for cotton the yield can be materially increased by leaving the plants close together in the row and that this close spacing increases the chances of making a crop either by setting bolls before the weevils become very numerous, or, when weevils destroy all of the first squares, by the greater drought-resistant qualities of the single-stalk plant.

Breeding work with Kekchi, Acala, and Lone Star was continued in an effort to produce a stock of uniform, locally adapted seed of these varieties. This work has been somewhat hampered by the unfavorable conditions obtaining at San Antonio during the past two

seasons. However, in 1920 considerable seed was produced and a number of promising selections made. The breeding block of Kekchi showed this variety to be particularly well adapted for culture under boll-weevil conditions (2).

EXPERIMENTS WITH CORN.

WORK OF THE OFFICE OF CEREAL INVESTIGATION IN 1919.[3]

Corn investigations at the San Antonio Experiment Farm in 1919 were conducted along the following lines: (1) A study of varieties in their relation to seasonal conditions, (2) observations of the growth and characters of foreign varieties, and (3) a study of yields as influenced by different methods and rates of planting.

In the San Antonio region, conditions late in the season are frequently such that late-maturing varieties are injured more than earlier varieties, because of insufficient moisture. When such conditions prevail, the best yields usually are obtained from the earlier varieties. On the other hand, when moisture conditions are favorable later in the season, long-season varieties will outyield short-season varieties. In 1919 the moisture supply was sufficiently abundant and well distributed to permit the normal development of all varieties tested. Varieties from southern and southwestern sources to the number of 34, ranging from very early to very late maturity, were grown in a variety test.

It is of interest to group these varieties according to the length of the growing season required and compare them as to height of plants and yields. These comparisons are shown in Table 4.

TABLE 4.—*Comparison of the heights and yields of varieties of corn grouped according to their length of season as grown on the San Antonio Experiment Farm in 1919.*

From emergence to pollen shedding.	Number of varieties.	Average height of mature plant.	Average yield of air-dry corn.
		Feet.	*Bushels.*
82 days	3	9.8	51.0
70 days	13	8.7	48.6
66 days	6	7.8	40.3
62 days	6	7.5	36.7
58 days	4	6.1	34.5
48 days	2	4.0	15.4

In Table 4 the number of days from coming up to first pollen shedding is used as the index of the length of the growing season of each variety. The pollen-shedding stage in the development of the

[3] This report was furnished by Mr. E. B. Brown, of the Office of Cereal Investigations, Bureau of Plant Industry.

plant can be determined definitely and is not subject to differences of individual judgment, as are dates of ripening. In general, the length of time required to reach pollen shedding is correlated with the length of time required to reach maturity. In this test the number of days from coming up to first pollen shedding are not averages, but represent the actual number of days for each variety within the respective groups. The height of plants and the yield per acre are averages.

The results bring out very well the greater average productiveness under continuing favorable conditions of late-maturing varieties as compared with earlier varieties. The highest individual yields were made in the second group; four varieties in this group outyielded the minimum yield in the first group. In general, however, there is little overlapping from one group to another, and where it occurs it is caused, in most instances, by increased production from F_1 crosses.

Favorable moisture conditions throughout the season, however, do not generally prevail, and entire reliance should not be placed in one variety. As mentioned in previous reports, it is desirable in the San Antonio region to grow at least two varieties that differ in length of season required. An early variety requiring 90 to 100 days and a late variety requiring 140 to 160 days to mature fully would be a good combination.

Varieties grown on an observation plat numbered 18 Spanish, 18 Peruvian, 17 Chinese, 11 Argentine, 10 Mexican, 9 Guatemalan, 3 Brazilian, 2 Russian, 1 Japanese, 1 Chilean, and 12 United States strains. Many of the varieties had characters of value, especially some of the Mexican, Guatemalan, and Brazilian varieties. They were less productive, however, than United States varieties.

The interplanting of early and late maturing varieties as a means of increasing yields, described in previous reports, was tested again in 1919. Three varieties were used: U. S. Selection 133 and U. S. Selection 204, early maturing, and Laguna, a late-maturing variety. A comparison of the yields of the combined varieties in the alternate-row plantings and the yields of the individual varieties in pure stands is presented in Table 5.

TABLE 5.—*Comparison of yields of varieties of corn grown together and alone on the San Antonio Experiment Farm in 1919.*

Varieties.	Yield of air-dry corn per acre (bushels).	
	Combined (planted alternately).	Singly (pure stand).
Laguna and U. S. Selection 133	42.4	28.3
Laguna and U. S. Selection 204	42.4	34.5
Laguna	.....	42.7

The yields from the alternate-variety plantings are no greater than Laguna in pure stands but are greater than either of the early-maturing varieties in pure stands. As already shown in Table 3, high yields were associated with late maturity in 1919, so that it is not surprising to find the late variety in pure stands yielding as much as the combined yields in the alternate-variety plantings. Since the method of alternating early and late maturing varieties shows no material decreases in yields under the conditions of 1919 and has shown increases in yields in drier seasons, it would seem to be of value for general application in this region.

The relative efficiency of prolific and single-ear varieties in adjusting themselves to varying stands was tested again in 1919. The results confirmed those reported in 1918. At spacings of 8, 12, 14, 16, and 22 square feet per plant, the prolific variety gave 17, 26, 32, 17, and 50 per cent increases in yields per plant over the single-ear variety, thus demonstrating its greater efficiency in adjusting itself to different spacings. On the basis of bushels per acre both varieties made their maximum yields at the spacing of 8 square feet per plant. 46 and 53 bushels per acre, respectively, for the single-ear and the prolific types.

Since in both total yield and relative efficiency the prolific was superior to the single-ear variety, it would seem to be the more desirable for general use in this region, where thin stands are often advisable because of probable deficiencies of moisture during the growing season.

WORK OF THE OFFICE OF CEREAL INVESTIGATION IN 1920.[4]

Seven varieties were used in the corn experiments at the San Antonio Experiment Farm in 1920. These varieties yielded in the order listed in Table 6.

TABLE 6.—*Yields of seven varieties of corn as grown on the San Antonio Experiment Farm in 1920.*

Variety.	Description.	Source.	From emergence to pollen shedding.	Yield of air-dry corn per acre.
			Days.	*Bushels.*
Laguna	White dent	San Antonio, Tex.	76	50
Brazos	do	Waco, Tex.	74	50
Arlington Prolific	do	Marshall, Tex.	74	43
Surcropper	do	Sherman, Tex.	63	41
Singleton	Strawberry dent	Waco, Tex.	75	40
White Mogul	White dent	Eagle Lake, Tex.	81	39
San Miguel	do	Las Vegas, N. Mex.	56	28

[4] This report was furnished by Mr. E. B. Brown, of the Office of Cereal Investigations, Bureau of Plant Industry.

The San Miguel is a very early maturing variety and did not yield so well as the later varieties under the seasonal conditions prevailing in 1920. This variety is of value if early maturity is desired or for truck gardening. The quality of the grain produced was good. The White Mogul was the latest maturing of the varieties grown. The quality of the ears was excellent, but the yield was less than from the other varieties, with the exception of the San Miguel.

A comparison of plantings at different spacings in the row showed, as in previous experiments, that the prolific type of corn was more efficient in adapting itself to varying stands than was the large single-ear type. The results are presented in Table 7.

TABLE 7.—*Effects of different spacings upon the productiveness of two types of corn on the San Antonio Experiment Farm in 1920.*

Type.	Area per plant.	Yield of air-dry corn per acre.	Average number of ears per plant.	Average weight of ears.	Average number of suckers per plant.
	Sq. feet.	*Bushels.*		*Pounds.*	
Single ear	4.1	50.0	0.97	0.380	0.083
Prolific		49.0	1.14	.323	.026
Single ear	8.2	40.0	1.02	.536	.031
Prolific		45.0	1.55	.397	.078
Single ear	10.2	34.0	1.02	.524	.291
Prolific		44.0	1.81	.408	.192
Single ear	12.3	31.0	1.19	.540	.140
Prolific		33.0	1.75	.384	.465
Single ear	18.0	22.0	1.37	.469	.133
Prolific		32.0	2.37	.392	.333

The maximum yields of both types of varieties were made at 4.1 square feet per plant. The single-ear variety at this spacing (4.1 square feet) outyielded the prolific variety by 1 bushel per acre, but at the remaining spacings it was outyielded by the prolific variety by 2 to 10 bushels per acre. The single-ear variety shows a difference of 28 bushels per acre between its maximum and minimum yields, whereas the difference in the yields of the prolific variety at the same spacings is but 17 bushels. The number of ears per plant in the single-ear variety increases from 0.97 to 1.37 as the spacing between plants increases. Under the same conditions the prolific increases from 1.14 to 2.37 ears per plant. The single-ear variety shows greater variation in size of ear at the different spacings than does the prolific. The average weight of ear for the single-ear variety ranges from 0.380 to 0.540 pound. The average weight of ears of the prolific variety under the same conditions ranges from 0.323 to 0.408 pound. Increasing the number of ears rather than the size of ears appears to have been the more efficient method of increasing the total yields.

The interplanting of short-season and long-season varieties in alternate rows increased yields as compared with pure plantings of the early varieties and one of the late varieties, but yielded less than the pure plantings of the other varieties. The data are presented in Table 8.

TABLE 8.—*Yields from pure stands and interplanted stands of short-season and long-season varieties of corn on the San Antonio Experiment Farm in 1920.*

Variety.	Number of plants per acre.	Yield of air-dry corn per acre.	Average height of stalks.
		Bushels.	*Feet.*
Pure stands:			
Brazos	4,960	48.0	8.5
Laguna	4,560	46.0	8.5
Arlington Prolific	5,120	44.0	8.5
White Mogul	4,800	34.0	10.0
Surcropper	4,960	33.0	7.5
San Miguel	6,400	31.0	5.5
Interplanted stands:			
Brazos and Surcropper	5,620	44.0	.....
Laguna and San Miguel	7,840	40.0	.....
Arlington and San Miguel	7,660	40.0	.....
White Mogul and Surcropper	5,320	41.0	.....

This method of planting shows no special advantages or disadvantages for the seasonal conditions prevailing at the experiment farm in 1920. Several promising F_1 crosses were grown in isolated plats, to produce greater yields of pure seed for continuing selections. A shortage in rainfall during March and April tended to keep down the early vegetative development, causing the stalks to be relatively short. An abundance of rainfall during the latter part of May and during June at the time the corn was tasseling and silking was favorable to large yields.

TEXAS FIELD CROPS ASSOCIATION CORN-VARIETY TEST.

Several strains of a few varieties of corn and one strain each of a few other varieties were planted in a comparative yield test for the Texas Field Crops Association in 1919. A plat of four rows, or an area of one twenty-fifth of an acre, was planted to each variety or strain. A check variety was planted on each fourth plat. The planting was on March 20, which is rather late, but a favorable season resulted in very good yields. This experiment was not continued in 1920. The results of this test are shown in Table 9.

The highest yield was made by Strawberry. Laguna produced only slightly less and in other tests showed a higher percentage of shelled corn than Strawberry. The Laguna used in this test had been selected at the station for several years and is a variety considered well suited to the conditions of this region.

TABLE 9.—*Yields of corn in a variety test for the Texas Field Crops Association on the San Antonio Experiment Farm in 1919.*

Variety.	Yield per acre.	Number of plants per acre.	Average weight of ears.	Number of ears per 100 stalks.
	Bushels.		*Pounds.*	
Check (Chisholm)	43.2	5,350	0.588	96.2
Ferguson Yellow Dent (House)	40.5	5,375	.562	93.9
Ferguson Yellow Dent (Holmes)	45.5	5,525	.618	93.2
Ferguson Yellow Dent (Plangman)	45.0	5,425	.597	96.9
Check	45.1	5,400	.575	101.8
Ferguson Yellow Dent (Keen)	46.2	5,400	.594	99.5
Ferguson Yellow Dent (F. S. F.)	45.9	5,300	.609	101.4
Strawberry (Kirkpatrick)	53.0	5,375	.678	98.3
Check	45.2	5,575	.583	102.8
Improved Selection (House)	44.3	5,425	.624	110.3
June corn (Connelly)	43.9	5,625	.502	108.1
Laguna (U. S. E. F.)	50.7	5,700	.594	108.4
Check	47.7	5,700	.569	103.1
Chisholm (F. S. F. No. 1240)	46.8	5,775	.576	98.7
Chisholm (G. Thomas No. 1335)	47.9	5,475	.610	101.9
Chisholm (Cliet No. 1336)	47.0	5,975	.598	92.4
Check	49.3	5,925	.576	100.4
Surcropper (Lyon)	44.8	5,750	.515	106.3
Surcropper (House)	43.9	5,800	.554	95.7
Surcropper (Black and Craft)	45.2	6,025	.516	101.2
Check	47.6	6,175	.568	95.2
Surcropper (Ricketts)	44.7	5,700	.477	111.0
Surcropper (F. S. F)	43.2	5,650	.548	97.6
Surcropper (Riley)	40.5	5,725	.490	101.2
Check	37.3	5,650	.515	90.2

There are several strains of the three varieties, Ferguson Yellow Dent, Chisholm, and Surcropper. In each case the strain marked "F. S. F." is the original from which the others were derived.

EXPERIMENT FARM CORN-VARIETY TEST.

Ten varieties of corn selected from those thought to be well adapted to this region were planted on March 1, 1919, in tenth-acre plats, each plat containing four rows 264 feet long. The object was to obtain data regarding these varieties and to test their comparative yielding powers on a larger scale than had been done. The results of this test are shown in Table 10.

TABLE 10.—*Yields of corn in a variety test on the San Antonio Experiment Farm in 1919.*

Variety.	Yield per acre.	Number of plants per acre.	Average weight per ear.	Shelling.	Number of ears per 100 stalks.
	Bushel.		*Pound.*	*Per cent.*	
Laguna	50.2	5,540	0.490	82.7	125
Ferguson Yellow Dent	48.9	5,430	.561	84.2	106
Singleton	44.6	5,320	.541	78.5	110
Selection 165	47.9	5,400	.591	81.6	106
Brazos	46.8	5,410	.573	80.0	104
Chisholm	44.2	5,623	.554	81.6	97
Chaney	42.6	5,170	.583	83.3	94
Surcropper	39.1	5,210	.477	81.3	108
Horton	44.1	5,300	.579	79.9	101
Squaw	32.6	5,460	.305	80.0	137

Laguna outyielded every other variety and also was more prolific in that it produced more ears per 100 stalks than any other variety except Squaw. Squaw is the earliest variety and suckers heavily, nearly every sucker bearing a small ear. The earlier of these varieties are Horton, Chisholm, Surcropper, and Chaney. The others are medium late in maturing. This experiment was not continued in 1920.

CORN AND COWPEAS IN WIDE-SPACED ROWS.

An experiment to determine the value of planting corn in rows wider apart than is the usual custom and the advisability of interplanting with cowpeas was begun in 1915. This experiment has been planted each year since that time, but the results obtained have not been satisfactory to date. The plantings of 1916 were a total failure, while those of 1917, 1919, and 1920 were only partly successful.

In 1919 four plats of 10 rows, each 264 feet long, were planted on land which had grown cotton in 1918. The distance between rows in the plats varied from 4 to 7 feet. The corn was thinned in such a manner as to keep the number of plants per acre as nearly equal as possible in each plat. When the corn was just starting to tassel the plats were divided in halves and Whippoorwill cowpeas seeded between the rows in half of each section of each plat. This method of seeding was to avoid as far as possible the variation in results due to nonuniformity of soil and moisture. The date of seeding cowpeas was much later than usual, and poor growth was made. A heavy windstorm blew down the corn and so badly tangled the peas that harvesting was not attempted.

In 1920 a similar experiment was planted. The stand obtained was so poor in rows spaced at 7 feet that this plat was abandoned. Whippoorwill cowpeas were seeded between the rows on half of each plat, following the last cultivation, when the corn was approximately 4½ feet tall. The peas made very satisfactory growth and observations indicated that good yields of seed were produced. Owing to the suspension of the active operation of the experiment farm after June 30, it was not possible to harvest and record the yields of the peas in this experiment.

The results recorded from this experiment in 1919 and 1920 are presented in Table 11.

No material difference in yield is shown between plats growing cowpeas and those of similar row spacing but not interplanted. Also the yields and stands vary inversely as the distance between rows. These results would naturally be expected in years of favorable moisture supply, such as 1919 and 1920. Results of former years (6, 9) indicate that in seasons of deficient rainfall somewhat higher yields may be expected from the more widely spaced rows. When cowpeas

are planted between corn rows after the corn has attained a growth of 2 or 3 feet, no decrease in the yield of corn should be expected, and a good yield of hay may be harvested in favorable seasons. This practice can be highly recommended when the corn is to be hogged-off.

TABLE 11.—*Yields of corn in width-of-row tests on the San Antonio Experiment Farm in 1919 and 1920.*

Plat.	Distance between rows.	Yield per acre (bushels).		Number of plants per acre.	
		1919	1920	1919	1920[a]
Without cowpeas:	*Feet.*				
No. 1	4.1	46.4	43.2	5,352	.....
No. 2	5.0	47.0	39.5	4,989	.....
No. 3	6.0	45.2	34.4	4,917	.....
No. 4	7.0	41.0	.....	4,582	.....
With cowpeas:					
No. 1	4.1	46.6	44.3	5,528	.....
No. 2	5.0	46.0	41.8	5,174	.....
No. 3	6.0	47.2	34.9	4,785	.....
No. 4	7.0	41.4	.....	4,408	.....

[a] Stand counts were not made in 1920.

EXPERIMENTS WITH SORGHUMS.

A number of varieties of grain and forage sorghums were tested in cooperation with the Offices of Cereal Investigations and Forage-Crop Investigations. In 1919 these varieties were planted on field C4 on March 22. Good stands were obtained, and all varieties were thinned to one stalk every 3 or 4 inches in the row. The rows were 4.1 feet apart.

TABLE 12.—*Yields of field-cured forage in the variety tests of sorghums on the San Antonio Experiment Farm in 1919.*

[Abbreviations: C. I., Office of Cereal Investigations; F. C. I., Office of Forage-Crop Investigations; S. P. I., Office of Foreign Seed and Plant Introduction.]

Variety.	Number.	Average height of stalk.	Yield per acre.
		Inches.	*Pounds.*
Dwarf broom corn	C. I. 442	45	3,400
Acme broom corn	C. I. 243	60	3,600
Sumac sorghum	Commercial	70	7,950
Clubhead sorghum	F. C. I. 8708	71	7,500
Whooper sorghum	F. C. I. 5873[a]	70	6,550
Darso sorghum	F. C. I. 1530	57	6,200
Valley Brown kaoliang	C. I. 309	78	5,800
Manchu kaoliang	C. I. 171	76	4,550
Brown kaoliang	S. P. I. 38463	85	7,050
Sweet kafir	S. P. I. 32707[a]	75	6,600
Schrock kafir	F. C. I. 1481[a]	60	6,750
Sunrise kafir	C. I. 472	71	6,300
Dawn kafir	C. I. 340	51	5,000
Dwarf hegari	S. P. I. 34911	53	4,250
Improved feterita	S. P. I. 22329	66	6,400
Feterita	C. I. 182	68	5,800
Dwarf milo	C. I. 332	57	5,240

[a] Old seed.

The earliest varieties began to head about May 30 and the latest about June 11. The midge did considerable damage to the later varieties. Continued rainy weather delayed harvesting several days past the proper time, and birds got nearly all the seed. The broomcorn brush was pulled on July 9 and 10, and thrashed immediately. All varieties were cut with a row binder on August 1 and shocked. No attempt was made to harvest the seed of any variety. Table 12 shows the yields of forage obtained from each variety.

The Dwarf broom corn, C. I. 442, made 497 pounds and the Acme broom corn, C. I. 243, 787 pounds of brush per acre.

The Sumac variety of sorghum made the highest yield, nearly 4 tons per acre. The seed used was procured on the local market. The lowest yielding variety except the broom corn was Dwarf hegari, with a little over 2 tons per acre.

After harvest all varieties made a second crop, which observations indicated was as heavy as the first, with the varieties yielding in about the same order. A heavy windstorm on September 14 blew this crop down and tangled it so badly that no attempt was made to harvest the varieties separately. Less seed developed on the second crop than on the first, largely because of injury by the sorghum midge. No second crop of broom corn was harvested, all heads being very light and short.

In 1920 a similar test was planted on April 27 on field C3. Notwithstanding the late planting, a very good growth of all varieties was obtained. Practically no seed was set, as the sorghum midges were present in large numbers as soon as the first heads appeared. Work was suspended at the farm before any of the varieties were ready for harvest, and no data regarding relative yields were obtained.

EXPERIMENTS WITH SMALL GRAINS.

Five varieties of wheat, one of rye, one of barley, three of oats, and nine strains of oats (originally selected from one of the three varieties) were seeded on field D3 on November 12 to 18, 1918. Each variety and strain occupied an area of one-tenth of an acre. Good stands were obtained in all cases. Excessive rainfall throughout the fall and winter caused the plant growth to be too rank, resulting in much lodging and reduction of the grain yield, especially so with the oat varieties. Clean harvesting of the latter was impossible, and since much of the grain was lost through this cause the yields obtained from the different strains are not entirely comparable. The harvesting of the other grains was more satisfactory, and their yields are comparable. All varieties of oats and the Club variety of wheat were seriously injured by leaf rust. Early Baart and Kubanka wheat were injured very slightly by the rust, while rye and barley were practi-

cally unaffected. The yields from the grains in the varietal test for 1919 are shown in Table 13.

TABLE 13.—*Yields of oats, barley, rye, and wheat in the variety tests on the San Antonio Experiment Farm in 1919.*

Grain and variety.	Grain per acre.	Rust infection.	Source of seed.
Oats:	*Bushels.*		
Selection 213	12.8	Heavy	S. A. E. F.[a]
Selection 813	28.3	do	Do.
Selection 1013	21.6	do	Do.
Selection 1913	50.3	do	Do.
Selection 4413	27.7	do	Do.
Selection 5713	30.9	do	Do.
Selection 7413	31.6	do	Do.
Selection 7513	18.4	do	Do.
Selection 8113	28.4	do	Do.
Ferguson No. 71	68.0	do	Sherman, Tex.
Texas Red Rustproof	51.7	do	Commercial.[b]
Applers Bulk	22.7	do	Do.
Wheat:			
Mediterranean	.....	Medium	Do.
Kubanka	27.0	Very light	Do.
Early Baart	27.0	do	Sacaton, Ariz.
Sonora	19.2	Medium	Do.
Club	8.2	Heavy	Do.
Rye:			
Texas	26.3	Very light	Commercial.
Barley:			
Winter	41.1	do	Do.

[a] Selections made in 1912 from Applers Rustproof oats.
[b] Commercial seed procured from local seedsmen.

A grain variety test was planted in tenth-acre plats on field B4 on November 13, 1919. Four varieties of oats, two of wheat, and one each of barley and rye were used in this experiment. Good stands were obtained with all varieties except Early Baart wheat. Rust infection was generally heavier in 1920 than in 1919. Moderate temperatures and an abundance of moisture during the fall and winter induced heavy plant growth of all varieties, which rapidly exhausted the soil moisture when a protracted dry spell began the latter part of January. This combination materially reduced the grain yields below midwinter expectations. With the exception of Early Baart wheat, the stand of which was not more than 50 per cent, practically no lodging occurred. The yields obtained are given in Table 14.

Of the oat varieties Texas Red Rustproof yielded second highest in 1919 and lowest in 1920. From notes taken during the growing season, this variety showed less uniformity in growth and ripening than any of the others. Applers Bulk, Selection 1913, and Ferguson No. 71 were noticeably uniform in both growth and maturity. The variety Ferguson No. 71 outyielded all others in the test during the past two years and was fully as uniform and early in ripening as any.

In 1919 the two wheat varieties Kubanka and Early Baart gave identical yields and were only very slightly damaged by rust. In

1920 a very poor stand of the Early Baart variety was obtained and it was much more heavily infected with rust than the Kubanka. Winter barley made very good yields both years. This grain makes fully as good winter growth as oats and has regularly shown more rust resistance. Its substitution for oats as a winter pasture crop seems advisable.

TABLE 14.—*Yields of oats, barley, rye, and wheat in the variety tests on the San Antonio Experiment Farm in 1920.*

Grain and variety.	Date of maturity.	Grain per acre.	Rust infection.	Source of seed.
Oats:		*Bushels.*		
Applers Bulk	May 5	23.8	Very heavy	Commercial.[a]
Ferguson No. 71	do	26.6	Heavy	Sherman, Tex.
Selection 1913	do	22.5	do	S. A. E. F.[b]
Texas Red Rustproof	May 7	20.3	do	Commercial.
Wheat:				
Kubanka	May 20	20.2	Very light	Do.
Early Baart	May 9	12.8	Heavy	Sacaton, Ariz.
Rye:				
Texas	May 11	24.6	do	Commercial.
Barley:				
Winter	May 9	25.8	Medium	Do.

[a] Varieties so designated were procured from local seedsmen.
[b] Selection from Applers Rustproof in 1912 and grown on the experiment farm since that time.

EXPERIMENTS WITH FIELD PEAS.

Variety tests of field peas were conducted in cooperation with the Office of Forage-Crop Investigations, from which the seed was obtained. Twenty varieties were seeded on November 13, at the rate of approximately 100 pounds per acre, on field A3. Each variety occupied an area of one-thirtieth of an acre. Satisfactory stands were obtained with most of the varieties, and all came through the winter without injury from frost. Harvesting was done on May 3 to 29, when the vines had practically all turned brown. The yields obtained are given in Table 15.

Seven of the varieties produced seed at the rate of more than 20 bushels per acre, while several others which produced very little seed made excellent vine growth. The Amraoti variety gave the maximum grain yield of 34 bushels per acre, while the Fraile variety, which produced only 10 bushels of seed per acre, gave the maximum yield of field-cured hay, at the rate of 2.85 tons per acre.

Two rate-of-seeding tests were planted November 13, using McAdoo field peas. In one the peas were planted in duplicate thirtieth-acre plats at rates of 100, 90, 70, and 50 pounds per acre, respectively. In the other test two 8-inch rows were planted at the rates of 70, 55, and 45 pounds per acre, respectively. Soon after the peas in this latter test were harvested a severe windstorm tangled the vines so badly that it was not possible to obtain comparable yields. The yields harvested from the thirtieth-acre plats are shown in Table 16.

TABLE 15.—*Yields of field peas in the variety tests on the San Antonio Experiment Farm in 1919.*

Variety.	Total crop per acre [a] (pounds).	Seed yield per acre.	
		Pounds.	Bushels.
McAdoo (new seed)	3,900	450	7.5
Solo, No. 1703	4,500	1,095	18.25
Carleton, No. 12887	5,400	1,305	21.75
Amraoti, No. 21709	4,800	2,040	34.00
Agnes, No. 22036	[b] 5,700	495	8.25
Arthur, No. 22038	[b] 4,500	390	6.50
Victoria, No. 22048	[b] 5,100	405	6.75
Peluschka, No. 22079	5,250	315	5.25
S. P. I. No. 22637	6,300	1,305	21.75
Andes, S. P. I. No. 23848	[b] 5,700	540	9.00
Lima, No. 23850	5,850	1,605	26.75
Vida, No. 23851	5,400	1,125	18.75
S. P. I. No. 24262	3,600	645	10.75
Fraile, No. 24314	6,300	600	10.00
Smiley, No. 24895	4,350	1,740	29.00
Brown, No. 25680	4,950	1,650	27.50
Golden Vine, No. 34941	3,300	1,095	18.25
Kerrville	(c)	(c)	(c)
Boerne	4,500	1,260	21.00
Berryman	[d] 1,500	120	2.00
McAdoo (1916 seed)	[d] 4,500	390	6.50

[a] Field cured. [b] Green. [c] Very poor stand. [d] Very green.

The results indicate that when grown for grain the optimum rate of seeding is approximately 90 pounds per acre under seasonal conditions such as prevailed in 1919. When grown for hay or to be turned under as green manure, it appears that not more than 50 pounds of seed need be used per acre.

TABLE 16.—*Yields of field peas in rate-of-seeding tests on the San Antonio Experiment Farm in 1919.*

Rate of seeding per acre.	Yields per acre.		
	Total crop, field cured (pounds).	Grain.	
		Pounds.	Bushels.
100 pounds	4,875	585	9.75
90 pounds	4,875	810	13.50
70 pounds	4,800	697	11.60
50 pounds	5,100	652	10.90

Tests similar to those outlined above were planted November 25, 1919, but a long period of wet weather, accompanied by frequent winds of high velocity, at the time the peas were maturing caused the ripe seed to sprout and the immature seed and vines to rot in the field before they could be harvested. The advisability of growing field peas in this region is doubtful even in seasons of favorable climatic conditions. The crop of 1919 is the only favorable one grown at the experiment farm since 1915.

EXPERIMENTS WITH FLAX.

Experiments with flax, in cooperation with the Office of Cereal Investigations, were first begun in 1914. Preliminary work indicated the possibility of growing flax in the San Antonio region as a winter crop. Various tests to determine its economic value, suitable varieties and cultural methods, and the optimum date of seeding have been conducted since that time.

The flax experiments of 1919 included date-of-seeding and variety tests. Successive plantings of one-thirtieth acre each were made on November 18, December 2 and 16, January 2 and 18, and March 1 on field C3. The variety C. I. No. 3 was used at the rate of 45 pounds of seed per acre in these tests. The stand obtained was not satisfactory in all cases and varied from 90 to 20 per cent of a perfect stand, as estimated at the time of harvest. The maximum yield, at the rate of 19 bushels per acre, was harvested May 6 from the plat seeded on November 18. The plat seeded on December 2 was a close second, yielding at the rate of 18.5 bushels per acre. Plats seeded later gave appreciably lower yields, although that seeded on March 1 gave the very good yield of 12.3 bushels per acre. Cool weather, which prevailed during the period of fruiting, and the plentiful moisture supply were no doubt responsible for these late-seeded plats making more profitable yields than ordinarily may be expected.

In 1920, variety tests similar to those of 1919 were conducted. The date-of-seeding test was not continued. On January 11, 1919, and February 2, 1920, five varieties of flax were seeded in tenth-acre plats and 12 varieties were seeded in 16-rod nursery rows. The yields obtained from the tenth-acre plantings for the two seasons are presented in Table 17.

TABLE 17.—*Yields of flax varieties in tenth-acre plats on the San Antonio Experiment Farm in 1919 and 1920.*

Variety.	Weight of crop per acre (pounds).				Seed per acre (bushels).	
	Total.		Straw.			
	1919	1920	1919	1920	1919	1920
I. C. No. 2	2,250	700	1,465	470	14.0	4.1
I. C. No. 3	1,950	800	1,255	545	12.4	4.5
I. C. No. 13	1,400	750	895	550	9.0	3.6
I. C. No. 16	950	700	740	430	3.8	4.8
I. C. No. 152	2,550	1,250	1,690	960	15.4	5.2

The variety C. I. No. 152 gave the maximum yield for both years. The one which gave the minimum yield for 1919, C. I. No. 16, was second highest in 1920. The low yield was undoubtedly due to the very poor stand of this variety in 1919. All the yields in 1920 were

below normal. Four of the varieties were harvested on May 22, while wet weather made it impossible to cut the fifth variety until June 7. Continued rains and heavy dews kept all varieties in the shock for another month. By this time much of the seed had rotted or sprouted and when thrashed on July 7 not more than half the seed could be saved.

Variety tests with flax have been conducted at the San Antonio Experiment Farm since 1915. During this time the maximum yields obtained have varied from 3.48 to 15.4 bushels per acre, and the season of 1919 is the only one in which profitable yields were grown. In seasons of mild winter weather, flax produces better yields if planted early in December or late in November than if seeded later. However, temperatures below 15° F. greatly reduce the stand and may entirely kill the young plants.

EXPERIMENTS FOR THE CONTROL OF COTTON ROOT-ROT.

In 1916 an experiment was started for the purpose of determining the value, if any, of using either acid phosphate or calcium acid sulphate fertilizers as a means of controlling root-rot in cotton. Results covering three years showed that such treatment has no effect in preventing root-rot under the conditions prevailing at San Antonio (9).

Other experiments, designed to study the effect of mulches on cotton root-rot, were made in 1917 and 1918. It was found that mulching had no effect on root-rot, the disease being as severe on the mulched area as on adjacent untreated land. These and the preceding experiments were discontinued at the end of the 1918 season.

A fact of common observation is that cotton does not ordinarily show the effects of root-rot until it has made considerable growth. It was assumed that the infection entered the roots after they had penetrated the soil below the usual plowing depth. An experiment to determine the depth at which this infection occurs was started in 1917. Six areas, 8 by 16 feet, on field C5, where the cotton had been badly infected with root-rot in 1916, were selected for this investigation. The soil was removed from three of these areas to depths of 18, 32, and 48 inches, respectively, and replaced by new soil from a location thought to be entirely free from infection. The soil from the remaining three areas was excavated to depths corresponding to the first three and allowed to aerate two or three days. It was then replaced in as nearly its original position as possible. These excavations were all made in February, 1917. It was expected that this treatment would throw some light on the effect of aeration of the soil as well as indicate the depth at which the infection occurs. The soil in these

areas was dry and comparatively loose from handling, and subsequent rainfall was insufficient to produce good growth of the cotton plants In 1917 two plants died on each of two plats where the soil was merely aerated. No plants died on any of the other areas. Infection occurred all around these plats. This lack of infection on the treated areas was no doubt due to the dwarfed development of the cotton rather than to the effect of the treatments given the soil on the root-rot organism.

Cotton was grown on the same field, including the treated areas, in 1918 and 1919. In 1918 a higher percentage of plants died of root-rot on the areas which were only aerated than on those where new soil was supplied, and the deeper the excavation the less serious the infection during the second season of cropping. In 1919 all plants died on all areas except the one excavated to a depth of 48 inches and filled with new soil. From the results of the investigation covering the three seasons it seems safe to conclude that root-rot is in the soil and is very little, if at all, affected by aeration; that any beneficial effects of aeration are of short duration and that root-rot occurs to a depth of at least 4 feet. These experiments were not continued in 1920.

TESTS OF RHODES GRASS.

The first planting of Rhodes grass at the San Antonio Experiment Farm was made in 1911. The severe winter which followed, 1911–12, killed practically the entire stand, and it was abandoned. In 1917 a planting of the grass was made on field B4, and in 1919 another plat on field A3 was seeded. Although the winters of 1918–19 and 1919–20 were comparatively mild, the stand of grass was observed to be much thinner each spring than it was the preceding fall. In the fall of 1919 the plat on field B4 was divided into four sections; two were mowed after growth ceased and two were left with a growth of approximately 18 inches of grass to afford protection. While the entire planting suffered a decrease in stand those areas which had been moved late suffered more severely, and the first cutting of hay from them in 1920 was very weedy.

From observations of the plantings made here the following conclusions have been drawn: (1) It is difficult to obtain a satisfactory stand from a first seeding, but this may be remedied by allowing the first crop to mature seed before harvesting. (2) Maximum yields may be expected from 2-year-old stands. The growth of grass on fields which are more than 2 years old is short and irregular. (3) Cured hay is relished by milk cows and work animals less than Sudan grass or well-cured sorghum hay. (4) Owing to the expensiveness of the seed and uncertainty of growing a stand, it is not advisable to recommend

the general use of Rhodes grass as a hay crop in the immediate San Antonio region.

HORTICULTURAL EXPERIMENTS.

Horticultural work at the San Antonio Experiment Farm was first begun in 1906, when a collection of fruit varieties, procured from commercial nurseries, was set out. Since that time a large number of both fruit and ornamental plantings have been added to the collection. In cooperation with the Office of Foreign Seed and Plant Introduction, tests have been conducted to find new varieties adapted to local conditions, to find suitable stocks most resistant to local soil and climatic variations, and to determine the adaptability of many native and foreign plants as ornamentals.

Climatic conditions in the months preceding the season of 1919 were very favorable to all horticultural plantings, and no late frosts occurred to kill the earlier varieties of fruit. A large percentage of the fruit trees bore good crops, and the ornamentals made good growth throughout the year. Moisture conditions were favorable for the 1920 fruit, but a late frost occurred the night of April 3 which entirely destroyed the crop of many varieties and materially decreased the yield of most of the others.

PEACHES.

From the results obtained during the past 15 years it appears that none of the many peach varieties tested can be relied upon to produce profitable yields from year to year. Those varieties which have proved to be most resistant to soil conditions and climatic vicissitudes are of the thin-skin type and are, accordingly, suited only to home consumption. Under the conditions prevailing in 1919 31 varieties produced medium to large crops of fruit, varying in dessert quality from poor to excellent and ripening over a period ranging from May 19 to August 18. During 1920 only nine varieties produced fruit, and the period of ripening extended from June 4 to July 20. The date of first-ripe fruit varies in the same variety from year to year by as much as two or three weeks, depending on seasonal conditions. Some of the better varieties as regards dependability of bearing, dessert quality of fruit, and size of crop, given with their approximate dates of ripening, are as follows: Arp, June 5; Honey, June 10; Annie Williams, June 20; Slappey, June 25; Tuskena, July 25; Carpenter, July 20; and Elberta, July 22. The Tuskena and Carpenter varieties are clingstones and suitable for spicing, while the other varieties are freestone and more desirable as fresh fruit.

PLUMS.

The plum is perhaps more generally adapted to this region than any other fruit tested. Practically all varieties so far tried have produced fruit with dependable regularity. There is a wide range, however, in both the productiveness and table quality of the varieties. Practically all plum trees bore fruit, both in 1919 and 1920. The entire crop of 1920 was badly damaged by insect pests, and most of the fruit fell from the trees as soon as it began ripening. The varieties which have proved to be the most desirable for the region during the past two years are Gonzales, Terrell, Gold Coin, Shiro, and Santa Rosa.

FIG. 3.—Jujube (*Ziziphus jujube*) tree set in orchard A-1 in 1917. The jujube, or Chinese date, is well adapted to San Antonio conditions and makes an acceptable addition to the home garden.

MISCELLANEOUS FRUITS.

One of the most promising of the foreign introductions is the jujube, or Chinese date (*Ziziphus* sp.). Several trees of this fruit have been on trial since 1907, and all those of the species *Z. sativa* and *Z. jujube* have proved hardy and very resistant to the diseases so disastrous to other fruit trees (fig. 3). Although it is not produced at present on a commercial scale in the United States, it is believed to have considerable possibilities, for when properly processed the fruit is very palatable and quite unlike any confection now offered in the markets. Good yields of fruit have been produced each season, regardless of climatic conditions.

Several varieties of Japanese persimmons are included in the experimental orchards. One variety, Costata, produced a small crop of fruit in 1919. During the season of 1920 several trees put on a

large crop of fruit, which, for some reason not known to the writer, was shed before ripening. One tree each of the varieties Okame and Costata ripened fair-sized crops of fruit of medium quality.

The apricot has never proved to be of value as a fruit for this section. The late spring frosts invariably prove disastrous, because of its habit of early flowering. The same adverse results have been obtained with the almond. In 1919 only one pecan tree (Alley variety) in the experimental orchards produced nuts. In 1920 no fruit was set on any of the pecan trees. Of the citrus fruits, the Rusk citrange produced a heavy crop, as usual, and continued to show no signs of succumbing to any fruit-tree malady. Comparatively small crops of fruit were produced on citrange trees of the Savage and Cunningham varieties. In 1920 two lemon trees each produced a few fruits. A large number of varieties of grapes have been tested on this farm. Fair to good yields were obtained in 1919 from the Sukfata, Champanel, Valhalla, and Xenia varieties. The first three, ranking as named, have proved the most dependable of all varieties tried. In the spring of 1920 all grapevines growing were severely pruned and no appreciable quantity of fruit was produced.

EXPERIMENTS IN CROP UTILIZATION.

An experiment with beef cattle, to determine the value of oats for winter pasture and Sudan grass for summer pasture, was begun in 1916. This experiment was continued throughout 1919 and until July 8, 1920. The two steers reported on in 1918 were used in this test during the first half of 1919. Two acres of oats, seeded on September 25, 1918, on field D3, were fenced in two equal lots, and on November 20, when the oats were about 12 inches tall and in excellent condition of growth, the steers were turned in. The steers at this time weighed 850 and 830 pounds, respectively. Under the favorable climatic conditions of the winter of 1918–19 the oats maintained a vigorous growth, and abundant pasturage was available at all times. From observations that were made it is believed that under similar favorable conditions, three-fourths of an acre of oats per steer will furnish ample feed. The steers were removed from the pasture on May 19, at which time they weighed 1,145 and 1,111 pounds, respectively, and had acquired a very good finish.

During the 180-day oat-pasturing period the steers made an average gain of 288 pounds of live weight, or at the rate of 1.6 pounds a day for each steer. These animals were included in a shipment to Fort Worth, and on June 6, when sold, topped the market at $13.50 and $12 per hundredweight, respectively. The average yield of oat hay on the farm for 1919 was 3.31 tons per acre. Assuming that the increase in live weight of the steers was worth 10 cents a pound, they paid $8.70 per ton for the probable quantity

of oat hay which could have been harvested. This is a return of $28.80 per acre for the oat pasture.

Two 1-acre plats on field C4 were seeded to Sudan grass on March 22, 1919. Practically all this land had been in Sudan grass pasture the previous season. A narrow strip along one side had been fallow. The seed bed was in fair condition, and with rains coming soon after planting a good stand was obtained. With the exception of one-third of one plat, all the Sudan grass was mowed on June 6 and 7, at which time it was in the bloom stage. On June 11 two yearling Red Polled steers classed as medium stockers were procured from a local rancher and turned into the Sudan grass pasture, of which one-third of an acre had been left uncut. Their weight at this time was 517 and 510 pounds, respectively. Sufficient new growth of grass had been made to maintain the steers, and the remainder of the old growth was mowed on June 23. It was necessary to make a second cutting of hay from the pasture on August 14. The grass furnished sufficient pasturage at all times, besides yielding two cuttings of hay up to December 1, on which date the steers were removed and final weighings made. The first steer weighed 718 pounds and the second 680 pounds, gains of 201 and 170 pounds, respectively, or a total gain of beef at the rate of 185 pounds per acre from Sudan grass during a pasturing period of 173 days.

A total of 10,536 pounds of hay was taken from the 2 acres of pasture in two cuttings. At $10 per ton this hay would have been worth $52.68, or at the rate of $26.34 per acre. The value of the gain in live weight at 10 cents per pound was at the rate of $18.50 per acre, or the total value of beef and hay from 1 acre of Sudan grass was $44.84. The average yield of Sudan grass hay on the farm for 1919 was approximately 8 tons per acre, the value of which, at $10 per ton, was $80.

On October 2, 1919, 2 acres at the south end of field D3 were seeded to Texas Red Rustproof oats for use in continuing the steer-pasturing experiment through the winter of 1919–20. A good stand was obtained and the oats made vigorous growth. The steers used in pasturing Sudan grass the previous summer were turned into the oat pasture on December 1, at which time the oats were approximately 10 inches tall. The oats were heavily infected with leaf rust, and during the winter suffered severely from frost. This injury was no doubt greatly aided by the action of the rust in decreasing the vigor of the plants. The oat-pasturing period ended on May 17, 1920, at which time the steers weighed 940 and 915 pounds, respectively (fig. 4). A shortage of pasture made it necessary to remove the steers to a dry lot, where they were fed Sudan grass hay for a total of 48 days during the oat-pasturing period. The total number of days pastured

from December 1, 1919, to May 17, 1920, was 119, during which time the steers gained an aggregate of 212 pounds. During the 48 days when kept in the corral they were fed a total of 2,436 pounds of Sudan grass hay and made an aggregate gain of 245 pounds. The average yield of oat hay on the farm for 1920 was 2.17 tons per acre. Assuming the value of the increase in beef due to oat pasture to be 10 cents per pound, the steers paid at the rate of only $4.88 per ton for the probable weight of oat hay which would have been harvested.

These same steers were carried in the dry lot on Sudan grass hay until May 24, when they were turned into Sudan grass pasture on field C4. Two acres of this field had been planted on March 26, and the grass was about 40 inches tall when pasturing began. Lack of

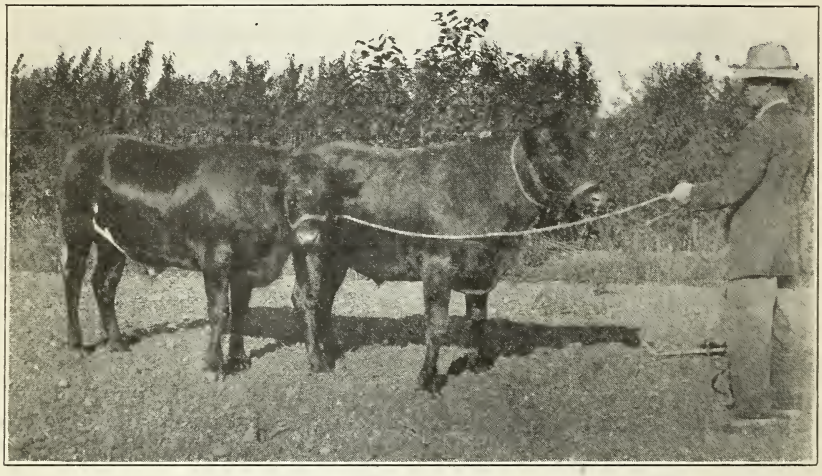

FIG. 4.—Two-year-old steers at the close of oat-pasturing period on May 19, 1919.

funds made it necessary to abandon this experiment, and the steers were accordingly removed from the pasture on July 8. During 45 days on the 2 acres of Sudan grass pasture, an aggregate increase of 85 pounds of beef was made. The steers were in excellent condition of finish when taken off pasture and brought the top price for the day when sold on the local market on July 10.

The results of this experiment show that in very favorable winter seasons, such as 1918–19, oats make a profitable pasture and that from three-fourths to 1 acre will be sufficient for a 2-year-old steer. In average years from 1½ to 2 acres of oat pasture will no doubt be required per animal. Steers can be maintained in excellent condition and will make some gain on Sudan grass pasture, but more satisfactory returns can be secured by feeding the grass in the form of cured hay. One acre of Sudan grass can ordinarily be depended upon to furnish pasture for two 2-year-old steers.

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